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# Language within a Language

## Scientific Concept Formation within Integrated Science and Language Learning

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## Abstract

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The aim was to investigate formation of specific concepts in some lessons of biology where English was the language of instruction.

Vygotsky's theory of meaning and sense realised during concept formation has become the background theory together with Lemke's notion of learning science through communicating science.

This case study research took place in a so called “total CLIL” environment. The concept formation was investigated by studying how the form in which the meaning of the concepts extracted from a textbook and represented by the teacher would change and develop when reasoned about by the students during the interviews. The content perspective focused on the semantic nuances between thematic patterns used in the textbooks and used by the teacher in relation to the thematic patterns presented by the students. The same thematic patterns were analyzed from the language perspective where it was investigated to what extent the thematic patterns represented by the students would approach semantically, by using school scientific and everyday language, the scientific patterns introduced in the textbooks and represented by the teacher.

The research concluded the notion that scaffolding of meaning making in the scientific subjects is essential for future appropriation and understanding. The research has found out that the students rather effectively use and combine school science language and everyday language in order to reason about the concepts, but that still only about half of them formed truly scientific concepts, and that the other half formed spontaneous concepts. The teacher's scaffolding plays the most important role in forming and consolidating the concepts in competition with students' pre-understanding.

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# 1. Introduction

Bilingual education is a very vast phenomenon of teaching foreign languages, having various realizations. One of the forms of bilingual education is immersion teaching, as the school subjects are studied through a second language. Immersion teaching has its origins in Canada; from Canada, it has spread to Europe, South America and many parts of Asia (Dalton-Puffer, 2011). Each country uses diverse methods of immersion teaching in its various contexts.

Application of Content and Language Integrated Learning (hereafter CLIL) depends on the environment in which the immersion teaching is implemented as there are many exterior factors that influence the realization of immersion teaching (Sylvén, 2010). Not only does it depend on a country but also on the region and the school itself how the immersion education will be realized. It equally depends on the mother tongue of the learners and teachers as well as on the official language or languages of the country. One of the dominant languages of immersion education is English, as the English language is considered to be a key literacy feature worldwide (Dalton-Puffer, 2011), spoken by 400 million people in 53 countries. English is also considered to be a second language spoken by more than 1.4 billion people (Research Trends, 2008).

Immersion teaching has been gaining popularity particularly through English. Not only because English is one of the most widely spoken languages in the world, but it has also been regarded as a leading language of science and research (Research Trends, 2008). Technical terms formed in English have been and still are adopted into many different languages all over the world.

CLIL is one of the ways of putting immersion education into practice. It is a method where content is taught through a second language. CLIL can be implemented within different subjects, both social science and natural science subjects. There are various ways of realizing CLIL depending on the extent of implementing CLIL into the curriculum. Most of the education is provided in English at the school where this research was conducted. This form of CLIL will be called “total CLIL teaching” in the thesis. It is important to realize that in order to penetrate deep enough into a certain subject, the language of discipline needs to be acquired (Gibbons, 2009). Every subject has its specific vocabulary, expressions and phrases, simply called its disciplinary discourse. Thus, to be able to understand and fully operate scientific terms and structures, scientific language needs to be mastered.

“Language within a Language” is the title of this thesis, indicating that when we express ourselves, we do not always use one language, but we talk through a language that can be situated within another language. The topic of the thesis relates to school science language of biology communicated in the CLIL environment where the language of instruction is English.

Airey stated that language within the disciplinary discourse of a subject needs to be mastered in order to appropriate the content of the subject (Airey, 2009). Therefore, the disciplinary language of biology is essential to be appropriated within the language of instruction. As there are two languages involved in teaching and learning, the language of instruction and the language of science, the title of this thesis is “language within a language” (Solomon, 1994).

Learning is described by Vygotsky as a process of appropriating concepts (Vygotsky, 1986). Regardless of content or language, everything we learn is through a process of appropriating concepts. Every appropriated piece of information needs to be formed into a concept. A concept needs to be discussed in order to be formed (Lemke, 2001). Concepts can be either of spontaneous or scientific origin; both scientific and spontaneous concepts are appropriated the same way (Vygotsky, 1986). As the term *concept* will be mentioned often in this thesis, the

meaning of this term will be clarified here: a concept could be reasoned as a representation of a subject. For example, when someone is in the process of forming the concept of a flower, she will most likely picture a flower she is familiar with. Such as a picture of a rose, tulip, or dandelion. Following on from this conceptualization, that person might connect the image to her previous life experience.

There are two origins of concepts: scientific and spontaneous (Vygotsky, 1986). Scientific concepts are mostly the concepts one appropriates at school. They are systematically organised and introduced by a teacher (Vygotsky, 1986). Spontaneous concepts are acquired “spontaneously” during everyday life experience. Scientific language will be used rather for formulating scientific concepts, unlike in the case of spontaneous concepts, when everyday language will be used (Solomon, 1994).

The aim of this thesis is to shed more light on CLIL teaching in the context of biology lessons in which the language of instruction is English. The study investigates language use in the context of school science. The focus of the study is to examine the extent of scientific content present in teacher and student reasoning, as indicated by content and language. It will be explored how this teamwork and coordination of content and school science language taught through English is realised in the lessons of biology.

The key intention of this study is didactic, as the focus is to observe CLIL teaching in a specific case-study in order to highlight different aspects of CLIL in practice.

## **2. Research Problem**

In order to acquire a piece of knowledge, a concept of that knowledge has to be formed (Lemke, 1990). The concept will be formed either into a scientific or a spontaneous concept. The students need to communicate their thoughts to be able to form the concepts. As this research will focus on lessons of biology, the interplay of school science language combined with everyday language will be used as a “tool” for the investigation of the concept formation (Olander, 2011).

The way that a concept, extracted from a textbook, is formed and mediated by the teacher will have an impact on the way the concepts will be formed by the students (Gibbons, 2009). Hence, the central point of departure of this investigation is:

- How meaning extracted from a text book is represented by the teacher and subsequently interpreted by the students.

### 3. Research Questions

As the thesis will be based on qualitative evidence, the research questions will be of a qualitative character. They focus on three different perspectives: first, concept formation from the content point of view; second, concept formation from the language point of view; and third, various aspects of learning and understanding brought by CLIL into teaching. The questions are following:

- How do the students communicate the concepts in the subject of biology?
  1. In what ways do the concepts develop during the process of their formation?
  2. What is the form of a concept created by an interplay of school science language and everyday language?
- Was the language of instruction causing any problems to the students in terms of understanding and learning?

The research questions are quite numerous. However, as the thesis is focusing on the concept formation from several perspectives, notably from the content and language perspective in the CLIL environment, it seemed important to bring out this number of questions.

### 4. Theoretical Background

The development of the concept formation represented by the students will be investigated within the CLIL environment of biology lessons.

The background theory for the concept formation was inspired by the notion of *thought and language* introduced by Lev Vygotsky, whose major objective was to prove that thought and speech have different roots, although they are closely interdependent on each other. According to Vygotsky a concept needs to be put into so called “verbal thoughts” in order to be created (Vygotsky, 1986). In other words, a concept has to be communicated through the medium of language. Lemke had a similar opinion stating that in order to appropriate science we must be able to “talk science”. If someone is able to verbally express a concept, it proves the ability of appropriating the concept (Lemke, 1990).

Vygotsky considered that every concept has its own *meaning* and its own *sense*. *Meaning* is the semantic “core” of a concept, closely related to what we call the “dictionary form” and “explanation” of a word. *Meaning* is therefore the form that is unitary and does not change depending on a situation it is used in. *Meaning* can have various *senses* related to the context it is situated in. *Sense* of a word is the personal creative aspect that “enriches” *meaning* depending on the context of the speech (Vygotsky, 1986).

Here is an example of the explanation of *meaning* and *sense* of the concept of *flower*: “Reproductive organ in plant containing one or more pistils or stamens or both, and usu. a corolla and calyx” (Oxford Dictionary, 1976). This explanation would be considered as a scientific concept being expressed through scientific language. On the other hand, the concept of *flower* could be also represented as: “Coloured (usually not green) part of a plant from which fruit or seed is later developed (Oxford Dictionary, 1976). It could be also stated that it is “a plant that is grown for the beauty of this part” (Longman, 1992), which would be considered as a spontaneous concept formation introduced through everyday language.

Scientific and spontaneous concepts differ from each other in the way they are formed. Scientific concepts are mostly the concepts that one acquires in a school setting; unlike spontaneous concepts that are formed during our everyday life experiences. However, the ability to define them comes much later after the concepts have been acquired. Scientific concepts are mostly appropriated by a definition or explanation at school. Therefore, one will find it natural to use the explanation when reasoning about a scientific concept. Spontaneous concepts are acquired spontaneously; there is no definition present at the process of acquiring a spontaneous concept. Therefore, it can be difficult to reason about a spontaneous concept. For example, when a child would be asked: “Have you got any brothers or sisters?”, she would know the answer as she knows the spontaneous concept of *brother*, as well as *sister*. But if she was asked: “Can you explain the meaning of the word *brother* or *sister*?”, she would find it very difficult to explain the concept from the abstract point of view (Vygotsky, 1986). In what age the concept formation is proceeded is also a very important aspect playing an important role in concept formation (Block, 1982 ). A vast amount of spontaneous concepts would be most likely formed at an early stage of the childhood. Unlike most of the scientific concepts that would be formed later at school.

Considering both scientific and everyday concepts, the concept formation will reach its final stage by a process that Vygotsky named the process of generalisation. It is the ability to reason about a concept without any connection to the context it was formed in (Vygotsky, 1986). In other words, it is the ability to reason about a concept situated in different contexts.

As has already been pointed out in the Introduction, the students need to master the language of instruction as well as the disciplinary discourse of the subject, in the case of this research the disciplinary discourse of biology. School science language is characterized by the use of technical terms and academic words (Lemke, 1990), unlike everyday language which is of an informal kind. Everyday language is used to describe everyday life situations and experience. Gibbons states that both of the languages should be present during the appropriation process. When teaching any subject, it is important to move from everyday language to the subject specific one in order to give a better insight into the facts that seem to be very abstract if they were only explained from the scientific point of view (Gibbons, 2009).

As Lemke stated: “The science in the dialogue is not just a matter of vocabulary.... It is the use of those terms in relation to one another, across a wide variety of contexts.” (Lemke, 1990, p.12). Knowing of a definition is not enough. A student needs to be able to talk a concept through by using scientific patterns and putting them together. Lemke introduced a term called “thematic pattern” (Lemke, 1990). A thematic pattern of a concept will be composed of expressions and language constructions that characterize the concept. If the extent to which school science language is present is high, a thematic pattern will be denoted as a “scientific pattern”. What plays an important role are the semantic relationships of verbs that characterize a concept within a thematic pattern. Therefore, the Language Analysis of verbs within thematic patterns of the given concepts will be a special subject of investigation. How is it going to be proceeded? “If the relationships themselves and the pattern in which they are joined is the same as what we would find in science textbooks or the language of professional scientists, we can say, that the thematic pattern of the dialogue is truly “talking science.” (Lemke, 1990, p.23) In other words, verbs contained in thematic patterns characterizing the concepts used by the students will be analysed in comparison to the thematic patterns in the textbooks and used by the teacher.

This case study research is situated in a CLIL setting. Thus, characteristics of CLIL and its origins is elaborated in more detail in the following paragraph. CLIL represents an umbrella term for all the teaching methods of immersion teaching where content is taught through a foreign language,



such as bilingual education or language medium teaching (cf. Nikula 1997, Hartiala 2000, Nixon 2000, Marsh 2002, cited in Sylvén, 2010). These methods vary, depending on a context, policy and implementation. Dalton Puffer characterizes CLIL as a “dual-focused” approach that gives equal attention to language and content (referring to Mehisto, Marsh & Frigols, 2008). She also describes CLIL as “an educational approach where curricular content is taught through the medium of a foreign language typically to students participating in some form of mainstream education at the primary, secondary, or tertiary level.” (Dalton-Puffer, 2011).

When it comes to the origin of CLIL, the first piece of research mentioning this teaching method comes from the late 1960s in Canada (Lambert 1977, cited in Sylvén 2010). The language of instruction was French and the purpose of the study was to improve students' French proficiency, as the students' mother tongue was English.

CLIL can be divided into three categories according to the amount of its implementation into curricula: The first and original form is called *early total immersion* where students are fully immersed in the target language at a very early stage. The second category is called *early partial immersion* that is introduced in half of the subjects at school. The third kind of immersion is called *the late immersion* as the target language is not introduced before grade 8. For this thesis the “total immersion” term is used as all the content subjects are taught through the language of instruction, yet, at the level of upper secondary school.

In Sweden, CLIL was introduced in 1977, as an experiment by a teacher (Åseskog 1982, cited in Sylvén, 2010). After that, CLIL has been implemented in many Swedish schools. The dominant language of CLIL in Sweden is English (Dalton-Puffer, 2011). Most of the CLIL appears at upper-secondary level in Sweden. Each school decides about the implementation of CLIL. Some of the schools tend to reserve CLIL for short-cross curricular projects, and some of them integrate CLIL in individual subjects (Euridice, 2006). At tertiary level we do not know much about CLIL research and its implementation, but Airey stated in his thesis that the research of CLIL has recently been moving towards tertiary level, so it would be possible to find out more in the near future (Airey, 2009).

Moate (2011) points out that the results of not implementing CLIL into policy framework can cause confusion, stress and fatigue to the teachers. Spain and the Netherlands are examples of the countries where CLIL teaching has been clearly set up. As a result of this fact, more research can be conducted in those countries (Dalton-Puffer, 2011). The consequence of unclearly stated frameworks can be the reason why the explored results of research about CLIL teaching in Sweden do not show as positive results as in other European countries such as Finland, Spain and Germany. Despite this fact, Sweden is one of the leading European countries in terms of English language proficiency. Although the results have shown that it is rather extramural English exposure that is the most prominent factor of high students' English language proficiency (Sylvén, 2013). It may indicate that among other factors the interest and motivation for learning English outside school environment must be increasing.

## 5. Methods and Participants

The research was conducted at a school situated in one of the larger cities in Sweden, in the central part of the city. The school has an international profile, in particular it provides a high school program called International Baccalaureate (IB), also called the Diploma Program. The IB program is a non-profit educational foundation established in 1968, and currently works with 3,777 schools in 147 countries. It is a two-year programme preparing students for future university studies. The program is highly respected and demanding. The IB Diploma qualification is recognised by leading universities around the world.

The IB curriculum is constructed by external management. For this reason it does not correspond with the Swedish curricula. As a result of this fact, the students are examined externally. The teaching and studying materials are specially designed for the international program. The language of teaching all the content subjects is English, which creates a form of CLIL environment that is denoted in this thesis as “total CLIL teaching”. Some of the students enter the two-year high school program with no previous experience of studying in English. Some of them had studied in English for various time spans before entering the high school program. This atmosphere of very diverse knowledge of English creates a difficult task for a teacher in terms of leading the lessons.

### 1. Study Sample and Procedure

In order to reveal a deep understanding of the concept formation, this study was a case study where one class was engaged with the research. Case studies focus on “individual units”, which can also be called “bounded systems” (Flyvbjerg, 2011, referring to Stake, 2008, pp. 119-120).

This case study focused on one class during several biology lessons lead by one teacher. As Flyvbjerg pointed out, a case study is an intensive study that should be placed in an environment and should monitor the study over a certain period of time (Flyvbjerg, 2011). This case was intensively studied in several steps: lesson observations, recorded interviews with the students and the teacher, transcription of the interviews followed by the analysis. In terms of environment the research took place in the IB-program during the lessons of biology. The textbooks played a very important part for the environment of this case study going together with the teacher's utterance as they were considered both as scientific patterns in the analysis in this thesis. The students were interviewed individually in the school library. The teacher's utterance was recorded during two consecutive lessons of biology introducing a unit “Defence Against Infectious Diseases”. The interview in the teacher's office was executed in order to give more general information about the lessons, the school and the IB-program in general.

An important part of the case study involved establishing a picture of one class by observation and video-recording. As a next step, interviews with six students were made and transcribed. The subject matter of the analysis was to investigate scientific and spontaneous concept formation in the topic “Defence Against Infectious Diseases” by means of school science language and everyday language use. The research was conducted at a high school level, in a grade 11 class. The data was generated during a sequence of two lessons and student interviews were the core body of data used in the analysis.

In terms of participants, a total of thirty-two students participated in the classroom observation. The class was ethnically diverse. A significant percentage, around 50%, was of Swedish origin. During three weeks after the first lesson of the video-recording, six students were interviewed. The interviews were recorded and executed in a semi-structured way. Each interview was between 20 to 30 minutes long. The interviews took place in the school library. The interviews

were lead in the traditional 'face to face' style as the interviewer was allowed to penetrate the students' thinking without influencing the answers too much (Solomon, 1994 referring to Leboutet-Barrell, 1976). General questions about the students' cultural background were given at the beginning of each interview.

The interviewer asked the following questions to begin each interview with: the questions concerning the language background and the questions investigating biology lessons in terms of language understanding.

Th second part of the interviews focused on the formation of four concepts. Four terms were presented to the interviewees on a sheet of paper written in a column in the following order: *pathogen*, *bacteria*, *virus* and *fungi*. The question was simply formed: "Could you explain these four terms to me as if I was a student who missed out the lectures when the terms were introduced?" If there was a moment of silence another question came about what the student associated the term with. Otherwise the interviewer was not intervening into the dialogue at that moment. Most of the students answered without any hesitation. Occassionally, some students seemed to be hesitating for a short while, but eventually they came up with an answer. The most frequent hesitation was happening during the concept formation of *fungi*.

Most of the students, apart from one, followed the order of the concepts written in the column. Therefore *pathogen* was presented first, *bacteria* and *virus* were introduced in relation to each other and mostly in connection the use of antibiotics; *fungi* was reasoned about as the last term.

The interviews were conducted about two weeks later after all the concepts were introduced during the lessons. They were intentionally executed not immediately after the lessons in order to find whether the students retained the concepts in their memory in a period of longer time (Vygotsky, 1986). The fact that the students were able to represent a concept was meant to probe how the concept formation developed on the basis of already existing schemes (Driver et al., 1994).

The election of the interviewed students was executed by means of a division of the students into three groups in order to interview six students. The primary aim of chosing this number of students was to distribute them evenly by two into three groups formed beforehand depending on their language background: Swedish spoken at home, English spoken at home and other languages than English and Swedish spoken at home.

Lindsay and Clarissa were chosen to represent the group using Swedish at home; Ester and Zahir were chosen to represent English and Jose and Sabrina other languages group. The way of electing the students was by asking the class the following questions: "Who speaks Swedish at home?", "Who speaks English at home?", "Who speaks other languages than Swedish and English at home?". However, later on the researcher found out that this kind of division was not accurate as most of the interviewed students spoke more than one language

at home in some cases including English and Swedish. Therefore, the final division of the students was decided to be proceeded according to their language background distinguishing: their mother tongue (mostly one with the exception of Jose who mentioned he speaks two mother tongues) and languages spoken at home.

The students were selected according to their language background for the purpose of the following analysis of the concept formation. The aim was to represent the variety of the students' language background as a solid sample for the analysis. Language background is an inherent part of the socio-cultural background of each student. As Solomon stated, the students' ideas about

science are reflections of the social influences and informal instruction which are accepted within the community. Therefore the students' language background may affect their future concept creation as a part of the socio-cultural background (Solomon, 1994).

The biology teacher, here called Sophia, was interviewed as well. Sophia was of non-native English origin and her teaching degree was accomplished outside Sweden in a country where English is widely understood and taught at a primary and secondary school as a compulsory subject. English is the language of instruction at most private colleges and universities in that country. So was the case of Sophia's university studies. Previously, she studied biotechnology. Afterwards, she completed her teaching degree in Science, mathematics and native language and after having completed her studies, she was teaching biology and her native language for five years in her homeland. She has been working at the upper secondary school in the international program since 2009.

Besides the interviews with the teacher and the students, the coordinator and the mentor of the international program were interviewed. The purpose of interviewing the coordinator and the mentor was to acquire more general information about the school, the program and its system.

In terms of methodology, the generalisation of the study in order to highlight its relevance in relation to other case studies executed in the similar research field by the similar methodology is the essential point of each research (Flyvberg, 2011). In order to generalize this case study the following thought was concluded: this study was situated in the IB-program where English is the language of instruction. The aim of this study was to explore the concept formation through scientific and everyday language taught through English. The question the generalisability of the findings will be further discussed in the Discussion chapter.

## **2. Plan for the Language Analysis**

The video-recorded lessons and recorded interviews were transcribed, especially those moments that were found the most adequate in relation to the aim of the research. Four related terms, namely *pathogen*, *bacteria*, *virus* and *fungi* extracted from the unit "Defence Against Infectious Diseases" were analysed within the subject of biology. The chosen terms could be considered essential knowledge of this unit.

It is important how the teacher forms the relationship between school science language and everyday language or common sense as it will result in how the students appropriate the concepts (Gibbons, 2009). The language analysis therefore proceeded through the employment of the scientific patterns used by the teacher and the thematic patterns used by the students in order to characterize the concepts. The teacher's and the students' concept formation was compared to the reasoning about the concepts in the textbooks. The aim was to see to what extent certain parts of speech, mainly nouns, adjectives and verbs in the thematic patterns approach the meaning of the concepts in the textbooks. In other words, the language analysis investigated the relationship of school science language and everyday language focusing on various parts of speech that are employed by the teacher and the students in order to characterize the concepts.

The aim of the language analysis was to demonstrate to the reader various ways of forming and reasoning about a concept depending on how much of scientific or everyday aspect was involved. This research investigated scientific patterns extracted from the textbooks and scientific patterns presented by the teacher during the lessons in comparison to the thematic patterns formed by the students during the interviews. The analysis was divided into three sequences: Content Analysis, Language Analysis and Language Aspects of CLIL Environment Analysis.

The Content Analysis was divided into several sequences where every concept was presented and analysed in three steps: 1.scientific patterns extracted from the textbooks, 2. scientific patterns represented by the teacher, 3.thematic patterns formed by the students when reasoning about the concepts. The Language Analysis investigated various parts of speech within the thematic patterns that represented either school science language or everyday language. The Language Aspects of CLIL Environment Analysis focused on the students' point of view. The aspects of studying and learning that CLIL implied were pointed out.

The questions aimed to find out how do the students, being non-native English speakers follow the biology lessons taught through English; and specifically, to what extent they combine their mother tongue with the language of instruction when studying at home and what their opinion about the provided textbooks was.

## **6. Analytic Procedure**

The analysis of the chosen terms was executed from a content and a language perspective. The content analysis explored the concept formation represented by the students during the interviews; the concept formation that was based on the teacher's representation and the textbooks use. It was observed, to what extent the semantic core of the concepts in the textbooks was modified when reasoned about by the students. The language analysis compared thematic patterns of the concepts contained in the textbooks and used by the teacher to the thematic patterns of the concepts formed by the students. It was investigated to what extent the semantic relationships of words and the concepts in the students' utterances approached semantic relationships of words and the concepts of the scientific patterns used by the teacher and stated in the textbooks. The presence of school science language and everyday language became be the “tool” of the investigation.

The interviews with six students were the core material of the analysis. The interviews were executed in a form of a dialogue between the interviewed student and the researcher. The dialogues focused on the explanation of four concepts. The aim was to evoke an everyday life situation where a student might be asked to explain either of the terms *pathogen*, *bacteria*, *virus* and *fungi*. During the interviews the students were asked to represent and classify the terms to “a classmate” (in this case the interviewer) who missed the lecture. Under this condition, the students were asked to reason about the concepts, they needed to be able to extract the concepts from the context of the lesson as well as the context of the textbooks and reason about them during the interviews using their own words. The researcher's aim was to see whether more complex, hierarchical genealogies would show how an individual relates the meaning of one concept to another (Solomon, 1994).

At the beginning of the interviews, the number of the languages that the students spoke at home were investigated, as most of the students were of non-native English origin. Six students were chosen to be interviewed from the three formed groups described in the Methods and Participants chapter. The table proposed below was formed in order to introduce the names of the students and their various language background. The table is divided into three categories denoting the students' mother tongue, second mother tongue and languages spoken at home:

Students	Mother tongue	Second mother tongue	Languages spoken at home
Clarissa	Swedish	-	Swedish
Jose	Spanish	Tagalog	Spanish, Tagalog, English, Swedish
Ester	Chinese	-	English
Zahir	Arabic	-	Arabic, English, Swedish
Lindsay	Swedish	-	Swedish
Sabrina	Spanish	-	Spanish, Swedish

The names of the students were modified in order to keep their anonymity.

As the table shows, one out of six interviewed students, Jose, speaks two mother tongues, Spanish and Tagalog. Three out of six students namely Jose, Zahir and Sabrina speak several languages at home. The remaining students, Clarissa, Lindsay and Sabrina use English only at school. Clarissa and Lindsay are of Swedish origin. None of the interviewed students have English as their mother tongue, although Ester (of Chinese origin) speaks English at home. The major aim of the interviews with the students was to find out how would they form the given concepts by combining school science and everyday language. Besides reasoning about the concepts, the interviews focused on investigating about studying in CLIL. The general questions about the students' background were given as well. The students' reasoning about the concepts was the third and final stage of the Analytic Procedure scheme proposed below the following paragraph.

In order to outline the entire plan of the analysis, a scheme was formed to show the particular stages of the research. Stage one represents textbooks used by the teacher as well as by the students. Stage two stands for the teacher's representation of the concepts during the lessons. The analysis focused the most on stage three, which represented the moment of students' formation of the terms *pathogen*, *bacteria*, *virus* and *fungi* chosen from the unit "Defence Against Infectious Diseases". The scheme was inspired by Vygotsky's notion of *sense* and *meaning* discussed in the Theoretical Background. The structure and its explanation are proposed below. The design of the scheme was formed in a following way: from meaning to sense to sense:

1.(from) meaning -----> 2.(to) sense -----> 3.(to) sense

Textbook 1, 2	teacher's representation	students' appropriation
school science	of the concepts during	and reasoning about the concepts
language	the lessons	based on the teacher's representation
	(mostly by lecturing or	school science language vs.
	giving a powerpoint	everyday language
	presentation)	

School science language was the language of scientific patterns used in the textbooks, therefore representing Stage 1. When the teacher presented a piece of unit, she most likely intended to preserve the scientific patterns but combined them with everyday language as well in order to make her statements easily understandable. Stage 3 indicates that the students combined school science language with everyday language when reasoning about the concepts (Lemke, 1990).

The process of concept formation started with Stage 1 denoting "(from) meaning". In this thesis it was presupposed that *meaning*, the "stable" part of a word, was the form of a concept written in the textbooks. School science language was the language of the textbooks. The students could choose to study from three textbooks that were named Textbook 1, 2 and 3.

Textbook 1 was the one the most frequently used by the students, followed by Textbook 2. The interviewed students stated that Textbook 3 was the least used as it was very brief and the content of the chapters did not always correspond to the subject of the lessons. The students did not either use it at all or they used it only as an outline.

*Sense* would be the personal creative part attributed to meaning depending on the context of the speech. Therefore the *sense* represented Stage 2 and Stage 3, as it was the teacher and consequently the students who reasoned about the concepts. When introducing a new concept, the teacher needed to find out a good balance between scientific and everyday aspects of a concept (Gibbons, 2009). During the teacher's representation of the concepts, the combination of school science and everyday language was employed as it is indicated in the scheme. Stage 3 approached the moment when the students were asked to reason about the terms during the interviews. The interviewer asked the question: "How would you explain the following concept to one of your colleagues who missed the lecture?"

## 7. Findings

The Content and the Language Analysis investigated the concept formation by means of school science language and everyday language in three different stages: (from) *meaning* of the concepts in the textbooks, through the teacher's representation of the chosen concepts and consequently the students' reasoning about these concepts. First, the Content Analysis is presented; second, the Language Analysis is introduced; and third, the Language Aspects of the CLIL environment is given.

### 1. Content Analysis

The aim of the Content Analysis was to investigate how the teacher's scientific and spontaneous concept representation developed into the students' concept formation. Therefore, the explanations of the terms extracted from the textbooks were proposed in several sequences, followed by the teacher's representation of the concepts, and the statements given by the interviewed students. After the representation of every term, a commentary is given summarizing the quoted parts. The order of the terms listed in the Content Analysis and subsequently the Language Analysis followed the succession of how the terms were introduced during the lessons: *pathogen*, *bacteria*, *virus* and *fungi*. Hence, the first sequence represented *pathogen*, the second sequence represented *bacteria* and *virus*, and the last sequence represented *fungi*. *Bacteria* and *virus* were put together into one sequence as the teacher introduced them in a close connection to each other.

#### Concept of pathogen

Textbook 1 defined *pathogen* as follows: "Any living organism or virus that is capable of causing a disease is called a pathogen. Pathogens conclude: viruses, bacteria, protozoa, fungi and worms of various types." (Textbook 1, p.163). The meaning of *pathogen* in Textbook 2 was very similar: "A pathogen is an organism or virus that causes a disease. Most, but not all, are microorganisms." (Textbook 2, p.193).

*Pathogen* was introduced by the teacher during the first of the two investigated lessons. It was the only term that the students did not encounter in any of the previous units. This was how the teacher introduced *pathogen*:

Teacher: the major agent that causes the disease or sickness is pathogen, first we can say they are organisms because they are living things; or virus, now virus is not a living thing because it doesn't show any living characteristics.

The term *pathogen* was described briefly. Here, the teacher pointed out the major distinction between *virus*, *bacteria* and *fungi*, which is that *virus* is a non-living organism unlike *bacteria* and *fungi*. As it can be seen from the extracted quotes, that virus is a non-living organism was described more illustratively by the teacher compared to the textbooks.

Jose formed the concept of *pathogen* as follows:



Jose: pathogen is an organism or bacteria that affects your body and gives you disease, that's what I think, like immediately. All of them are factors that can cause you diseases and informations. There are three different categories.

In the report above, Jose confused properties of *bacteria* with properties of *virus* as he denoted *bacteria* as a non-living organism and *virus* as a living organism, which indicates he most likely misunderstood the meaning of *bacteria* and *virus* as living and non-living organisms. However, he fully understood the meaning of *pathogen*.

Ester reasoned about the concept of *pathogen* in a different way from other students:

Ester: pathogen usually would be bacteria and virus and these three things they are, kind of not high level animal, this is not a cell, this is like very low, this has got 'auk...' something, it means that the cell doesn't have many things compound inside, it only have polymery, I don't know.

Ester intended to introduce the concept of *pathogen* by denoting *bacteria* and *viruses* as types of *pathogens*. She could also define *bacteria* as prokaryotic cells unlike human body cells which she defined as eukaryotic. She did not integrate *fungi* into the group of *pathogens*. However, she understood the meaning of *pathogen* as a superior term integrating *bacteria* and *virus*.

Clarissa could easily reason about the concept of *pathogen*:

Clarissa: viruses, bacteria and fungis are all pathogens and it's something that harms the body, it's like organisms. If they enter the body, the immune system, they're gonna fight them of, because they cause the diseases.

She correctly defined *viruses*, *bacteria* and *fungi* as *pathogens* causing diseases. She also described that the immune system defends *pathogens*, which indicates that she appropriated the meaning of *pathogen*.

Although Lindsay could not reason about the concept of *pathogen*, she remembered it was connected to diseases:

Lindsay: Ahm, I associate it to diseases.

From Lindsay's report it was not clear whether she was aware that *bacteria*, *viruses* and *fungi* are types of *pathogens*. She could connect *pathogen* to diseases in a form of association. Yet, she could not explain the meaning of *pathogen*.

Sabrina explained a reason why she was not able to represent the concept of *pathogen*:

Sabrina: Usually if it's funny, I remember, if it's not, I have to check again. Pathogen is not funny. (smiling)

Sabrina stated she could not connect the term to anything she had already known. She did not form the concept of *pathogen*.

During the interview, Zahir was not sure whether he remembered the correct meaning of the term. Nevertheless, he defined *pathogen* correctly:

Zahir: pathogens are.. yeah basically viruses, bacterias and fungus are types of pathogens. Pathogens are non-cells organisms that can attack your body. I'm not sure about the definition but that's what I remember.

He used his own expression 'non-cells organisms' for denoting *pathogen*. He was most likely thinking of *viruses* as they are acellular organisms (the term acellular means that virus is not formed by cells). However, at that moment he must have forgotten that *bacteria* are prokaryotic and *fungi* are eukaryotic organisms. Nevertheless, it can be stated that he clearly appropriated the concept of *pathogen*.

### **Concept of bacteria and virus**

*Bacteria* and *virus* were analyzed in one sequence as they were introduced together in relationship to the use of the antibiotics in the textbooks as well as by the teacher during the lesson. During the interviews, the terms were presented by the interviewer in the following order: *pathogen*, *bacteria*, *virus* and *fungi*. Some students reasoned about *bacteria* and *virus* together and some decided to present the terms separately. In Textbook 1, both *bacteria* and *virus* were denoted as types of pathogens in the definition of *pathogen*. *Bacteria* was presented in a form of revision as the students have already studied the term within the unit "Microorganisms". The definition was: "In order to understand how antibiotics work against bacteria, you need to recall that bacteria are prokaryotic cells and our body cells are eukaryotic cells." (Textbook 1, p.163).

The definition of *virus* was introduced in Textbook 2 in relation to *bacteria* and the use of antibiotics: "Viruses, on the other hand, are not living cells and have no metabolism of their own to be interfered with. Viruses reproduce using metabolic pathways in their host cell that are not affected by antibiotics. Antibiotics cannot be used to prevent viral diseases." (Textbook 2, p.195).

The teacher represented the terms as follows:

Teacher: bacteria is a living organism, it's a prokaryote, which means it doesn't have a clear nucleus, it reproduces by 'nurfition' that means that one cell will be divided into two cells so each time it reproduces,

it doubles. When you look at infections: eye infection, ear infection, and also food poisoning, Salmonella, those are very very dangerous bacterias, also diarrhoea and cholera, these are the basic ones. Bacteria has its own body, it's a prokaryote, unlike virus which is using host cells. Antibiotics are designed to block the metabolic pathway and living processes of the bacteria; you stop the reproduction, because bacteria shows specific life functions unlike virus, so antibiotics can work against bacteria, to make a cell wall or cell membrane of the bacteria. You block the DNA synthesis then it cannot copy the DNA, and you block synthesis of protein, but viruses it doesn't reproduce outside of the host cell, it will only reproduce inside a cell and therefore the antibody cannot act on them. Virus changes the whole cell DNA into their own DNA, it uses the whole cell into building material and after that, when the virus reproduce, it changes the host DNA, it uses the host DNA to double. After that it will burst the whole cell, the whole cell will die and these viruses will spread everywhere inside the body. But bacteria not, they will synthesize their own material to reproduce. The dangerous thing about virus is that it can evolve very fast, that means it can change the DNA composition and it can recombine it very quickly, then we don't know how to treat them because they change their form easily; for example HIV virus, smallpox, herpes. When your immune system is down then it will reoccur as "lichen", which is very painful.

At first, the teacher introduced *bacteria*, the way they reproduce and the most common infectious diseases they cause. The term *virus* was introduced during the lecture together with *bacteria*. The terms were put into contrast as they had different properties in terms of behaving in a host organism. Then the teacher explained the danger of *virus* in its fast reproduction and gave examples of the most common diseases caused by *viruses*. The teacher introduced bacteria and virus in a more detailed way compare to the introduction of the terms in the textbooks.

Jose represented *bacteria* and *virus* stating:

Jose: bacteria is a kind of a pathogen that gives you a disease. Virus is an organism that cannot be killed by antibiotics, and I think about blocking something but I don't remember what it was. Yeah I think of antibiotics that they cannot kill the virus, that's what I think. I think about diseases that you can get.

Jose remembered that a viral infection is not possible to treated by antibiotics. He appropriated the meaning of *bacteria* and *virus*. However, Jose still denoted *virus* as a living organism.

Ester represented *pathogen*, *bacteria* and *virus* altogether. Her explanation was unclear from the language point of view as she joined the program a couple of weeks before this research was executed and she admitted she was having difficulties with understanding English:

Ester: these three things (pointing at the written terms pathogen, bacteria and virus), they are, kind of not high level animal, this is not a cell, this is like very low, this has got “auk...” something, it means that the cell doesn't have many things compound inside, it only have polymery, I don't know. These are very simple, like in the cell it has got a very basic thing, in virus, but this one is not (pointing at the word fungi).

It seems that Ester intended to explain that *bacteria* are prokaryotic organisms unlike *fungi*. Apart from this division of prokaryotic and eukaryotic organisms, Ester's utterance was confusing. It was not obvious whether she fully appropriated the concepts of *bacteria* and *virus*.

Clarissa gave a very accurate explanation of both terms:

Clarissa: bacteria they have prokaryotic organisms and they are different from human body cells so that's how they live, they have their own cells and that's how they reproduce in their body. But the viruses they live of our own cells like they exploit the metabolism of the human body cell, like you cannot use antibiotics on viruses because then you would damage your own body cells. They don't live before they get into contact with human body cells.

In the example, she denoted *bacteria* as a prokaryote and she also mentioned its reproduction. She pointed out the difference between *bacteria* and *virus* in relation to the use of antibiotics. Clarissa fully appropriated both of the concepts.

After being asked to reason about the concepts of *bacteria* and *virus*, Lindsay stated that she could not remember anything but in a matter of seconds her statement came out:

Lindsay: bacteria, those are living organisms, they are really really small, tiny (smiling), they will cause harm to your body and you can treat them with antibiotics which you can't do with viruses because they are not, because they will like inhibit in your cells and you don't want to damage your cells. Virus, it's a non-living organism, kind of, which will live as a parasite basically in living organism and cause that organism harm. Now I can only think of HIV and stuff, cause that's a kind of virus.

In the extract she correctly introduced *bacteria* as a living organism which can be treated by antibiotics. She also presented *virus* as a non-living organism and compared *virus* to a parasite. She presented HIV as an example of a disease caused by *virus*. From Lindsay's utterance it can be seen she grasped the meaning of the concepts although she put a lot of common sense in her utterance.

Sabrina reasoned about *bacteria* by giving an example of her own experience with a bacterial infection. Afterwards, she presented *virus* by giving another example from an everyday life experience:

Sabrina: bacteria, I've had it myself, and what I remember is that it's not a virus, a totally different thing. And what rings a bell when you say a bacteria, is antibiotics, you should not not use antibiotics if you don't have bacteria because you can kill the good bacteria in yourself. And for example I've had sinusitis, do you know what it is? It's spelled like that.... it's when you have infection in mocus ways, so it's here and here (pointing at her nose), in your nose as well and it hurts like hell. It's so bad, and if you dont kill the bacteria when you need to, the first time you get it, it can come back. It's interesting to study these things because you know yourself a little bit even if you're not a doctor. The virus is something that can be inside you without being visually seen, I can have herpes for example, without knowing about it, and then I get a cold and then I get a ... , what do you call it, herpes..., on..., your mouth (laughs) and that's the virus showing it. Do you understand? Also you can pass it on without actually having developed it, you can have herpes now without having developed it and then you can kiss someone and he can get it even if it's not showing on you. It depends if he has a cut on his lip, then he would get it.

Sabrina remembered the fact that *bacteria* and *virus* were not the same by saying “it is a totally different thing”. She was also aware of 'good bacteria', which indicated she was connecting knowledge acquired at school with her everyday life as she associated the concepts with the specific examples: *bacteria* to the bacterial infection Sinusitis and *virus* to the viral infection Herpes. However, she introduced the concepts only by giving concrete examples and not reasoning about their meaning.

Zahir also aptly denoted both terms. Instead of determining *bacteria* as a prokaryote he used another expression, unicellular, which was correct, although it was mentioned neither in the textbooks nor by the teacher:

Zahir: bacteria, they are living organisms that, ehm, unicellular organisms, they could be useful and they could be harmful. And viruses are non-living organisms that, you could say, invade your body and cause sicknesses and diseases.

In his statement, Zahir classified *bacteria* as a living organism. By saying “they could be useful and they could be harmful”, he realised that not all bacteria cause diseases. He correctly determined *virus* as a non-living organism.

Although the teacher presented *bacteria* and *virus* in a more detailed way, none of the students, apart from Clarissa, mentioned the reproduction of *bacteria* or *virus*. Only Jose could think of “blocking something” but he could not remember more. The students'

utterances seemed to be rather drawn upon the textbook explanations than from the teacher's utterance. Lindsay and Sabrina gave a couple of examples of viral infections. Lindsay mentioned a viral infection introduced during the lesson and Sabrina mentioned viral infections that she experienced herself.

When focussing on the meaning of the concepts seems that Clarissa and Zahir reasoned about the concepts of *bacteria* and *virus* as scientific. Lindsay and Jose represented the concepts as spontaneous, by putting common sense in their utterances. Sabrina did not appropriate the concepts although she could name examples of viral infections that she experienced. It was not obvious from Ester's utterance whether she appropriated the concepts.

### Concept of fungi

The explanation of the term *fungi* was not represented in any of the textbooks. *Fungi* was only mentioned as a part of the definition of *pathogen* presented earlier in the analysis. Despite the lack of explanation of the term in the textbooks, the teacher introduced *fungi* during the second lesson as a part of the powerpoint presentation:

Teacher: fungi is a eukaryote, which means it has a real nucleus, the cell structure is more complicated and it reproduces by spores. Spores means that it can spread very far, the spores can withstand non- favourable environment, means if its cold, if it's not warm enough, it will not grow. But it doesn't mean it can sustain. Until it reaches suitable condition, suitable temperature with moisture and everything it will start growing again. If the spores remain in a fungi, it will not show when its the symptoms and it will not grow when its not suitable, but if the spores remain it has still possibility to reoccur when the condition suits them.

When introducing the term *fungi*, the teacher also explained its reproduction in detail. Afterwards, she presented several slides ( as *fungi* was introduced during the powerpoint presentation lesson) mentioning specific examples of the most common infectious diseases caused by *fungi*.

Jose reasoned about the concept of *fungi* in the following way:

Jose: fungi, I think about mushrooms (laughing). And about like small particles that come to your skin, that give you diseases and informations.

At first he attributed *fungi* to mushrooms. Afterwards, he mentioned it could be a type of microorganism that causes diseases in contact with human skin (by stating "small particles that can come to your skin").

Ester did not reason about *fungi* as pathogens. Nevertheless, she attributed *fungi* to mushrooms and decomposers:

Ester: I don't know, fungi is, I don't know, mushroom and it work, I don't know the word, like take away dead body, they use dead body to create enzymes to create, I don't know. Fungi is a different type of a cell from a virus.

As Ester attributed *fungi* to mushrooms and decomposers, it could be concluded that she formed two concepts of *fungi*, one associated with mushrooms and the other associated with decomposers. She denoted the concept of *fungi* as a different type of cell from a *virus*. She most likely meant that *fungus* is a eukaryote, unlike *virus* which is defined as an acellular organism.

Clarissa presented her flow of thoughts similarly to Ester:

Clarissa: fungis, well, I kind of know what it is but I don't know how it works or how it reproduces or anything. I think of mushrooms (laughing), cause they belong to the Fungi Kingdom. It's like a group or collective name for same organisms. Then I think of decomposers (smiling).

In the statement above, Clarissa admitted she could not remember how to reason about the term *fungi* in relation to the unit “Defence Against Infectious Diseases”. She associated *fungi* to mushrooms. Later on she could think of *fungi* as decomposers.

At the beginning, Lindsay had no recollection of the concept of *fungi*. After a while she could think of *fungi* as *pathogens*, stating:

Lindsay: I can just see pictures of them (smiling). Mostly the fungi part, that it can cause harm to your skin, I can see pictures or images from our textbooks you know, the illustrations. I think I've suppressed the stories mentioned during the class, cause I don't want to think about it (laughing).

She mostly remembered the pictures of *fungi* from the powerpoint slides presentation that formed the content of the lecture.

Sabrina attributed the concept of *fungi* to the moment when she studied about the Kingdom of Fungi in one of the previous chapters:

Sabrina: when we were studying kingdom families, I was studying with my mum who was trying to help me, we were sitting together and she was making funny faces and explaining to me, and she was saying this is like this and you remember, and then when we were writing a test I was just laughing because I remembered what my mum did, that was long time ago.

Sabrina connected *fungi* to a memory of her mother, when her mother was helping her at home with studying about the Kingdom of Fungi.

Zahir's interpretation of the concept of *fungi* was the following :

Zahir: fungi are the types of, you could say, living organisms that grow in the shades of the trees and they, you could say, consume some nutrients from the trees and the grass or the surrounding environment.

He characterised the term of *fungi* as mushrooms. He also described where the mushrooms grow and what the way of their alimentation is.

The analysis of the concept of *fungi* showed that five out of six interviewed students reasoned about the concept of *fungi* as mushrooms. Some of the students attributed the concept of *fungi* to *pathogen* or *decomposers* afterwards. From this study, it could be concluded that the concept of *fungi*, attributed to mushrooms, was formed into a spontaneous concept and the concept of *fungi* attributed to *pathogens* or *decomposers* was formed into a scientific concept (Vygotsky, 1986). However, reasoning of the scientific concepts came after the students presented the concept of mushrooms in the first place (except for one out of six interviewed students who did not reason about the concept as mushrooms). Moreover, the way the concepts of *fungi* as *pathogens* and *decomposers* were presented was not explanatory, mostly given as a form of association rather than reasoning by meaning (Gibbons, 2009).

## **2. Language Analysis**

The aim of the Language Analysis was to investigate how the concept creation would develop the language point of view, proceeding from the textbooks, represented by the teacher and reasoned by the students. The language analysis was proceeded through the analysis of the thematic patterns that are joined in the utterances that characterize the concepts. The aim was to shed more light on the parts of speech occurring in the thematic patterns, to analyze their semantic relationships and subsequently compare them to the thematic patterns used by the teacher and used by the textbooks.

The analysis was executed in the following steps: firstly, an explanation extracted from a textbook was introduced; secondly, the teacher's way of representing a concept during the recorded lesson was given; and thirdly, the students' quotations from the interviews were presented. Four terms listed in the Language Analysis followed the same order as in the Content Analysis.

### **Concept of pathogen**

This term was explained in Textbook 1 as follows: "Any living organism or virus that is capable of causing a disease is called a pathogen."

The teacher's representation was similar to the one in Textbook 1:

Teacher: the major agent that causes the disease or sickness is pathogen,...



The teacher used a similar thematic pattern as the one used in the textbook. Her version was more direct, as instead of saying “capable of causing” she simply used “cause diseases”.

The students' utterances were the following: Jose replaced the verb “to cause” by the verb “to give” by stating:

Jose: pathogen is an organism or bacteria that affects your body and gives you disease,...

Although Ester denoted *pathogen* in a rather peculiar way, the message of her utterance was understandable:

Ester: pathogen usually would be bacteria and virus and these three things (pointing at pathogen, bacteria and virus) they are, kind of not high level animal....

Prokaryotes were one of the first forms of life on Earth. Eukaryotes appeared later through the process of evolution and thus they are more complex and form more developed organisms. With the limited knowledge of her English, Ester wanted to explain the difference between *bacteria* and *virus* compare to *fungi*. When reasoning about these concepts she created a new expression “high level animal” to describe the more complex cell structure of *fungi*. Therefore it could be presumed that for describing *bacteria* and *virus* she would use “low level animal” expression explaining simpler structure of the cells.

Clarissa introduced *pathogen* as:

Clarissa: something that harms the body,...

In this thematic pattern, it is the verb “harm” that caught the researcher's attention. By using the expression to “harm the body” the listener or reader perceives a kind of action that is more explicit and striking compare to the verbs “can cause” (used by the textbook) and “cause” (used by the teacher).

Lindsay could only remember:

Lindsay: associate it to diseases.

Lindsay had a vague recollection of the fact that *pathogen* is somehow connected to diseases.

Sabrina simply stated that

Sabrina: pathogen is not funny.(smiling) Sabriba

had no recollection of *pathogen*.

Zahir stated that:

Zahir: Pathogens are non-cells organisms that can attack your body.

He used the verb “attack”, which made *pathogen* an active agent that is “attacking” the human body. The role of *pathogen* in the Zahir's interpretation became also more aggressive.

When investigating thematic patterns about *pathogens*, the researcher found out a very distinctive way of using verbs by the students. The students used more direct, explicit and striking metaphorical expressions such as to “give disease”, to “harm the body”, or even to “attack the body”.

### Concept of bacteria and virus

The concept of *bacteria* was introduced in the textbooks in a way as if its explanation had already been mentioned in previous chapters: “you need to recall that bacteria are prokaryotic cells, ...” The scientific pattern was extracted from Textbook 1.

*Virus* was introduced in relation to the use of antibiotics where it was explained why a viral infection cannot be treated by antibiotics: “Viruses, on the other hand, are not living cells and have no metabolism of their own to be interfered with.....” (extracted from Textbook 2)

The teacher transferred the scientific pattern from the textbook into a singular form stating “bacteria is a prokaryote”, adding that “it hasn't got a clear nucleus”:

Teacher: bacteria is a living organism, it's a prokaryote, which means it doesn't have a clear nucleus,...

*Virus* was introduced by the teacher by pointing out its different properties from *bacteria*:

Teacher: Bacteria has its own body, it's a prokaryote, unlike virus which is using host cells.

Jose used a similar thematic pattern for *bacteria* as he used for *pathogen*: Jose:

bacteria is a kind of a pathogen that gives you a disease.

In order to reason about *virus*, Jose used the verb “to kill”, stating that:

Jose: Virus is an organism that cannot be killed by antibiotics, and I think about blocking something but I don't remember what it was. Yeah I think of antibiotics that they cannot kill the virus, that's what I think. I think about diseases that you can get.

In the quote above, Jose did not characterize *bacteria* but classified it as a type of *pathogen*. He remembered the part explaining on what principle antibiotics work in order to defeat

*bacteria*, by 'blocking' the DNA synthesis. However, he could only remember the word 'blocking'. Afterwards, he used his own words, saying “antibiotics cannot kill the virus”. These thematic patterns carry the action verbs that are again very direct and apt in a way, yet representing rather common sense part and therefore everyday language (Lemke, 1990).

From Ester's utterance it could be suggested that she denoted *bacteria* as a prokaryotic organism unlike *virus*, which she characterized as an acellular organism in her own words:

Ester: these three things (pointing at the written terms pathogen, bacteria and virus), they are, kind of not high level animal, this is not a cell (pointing at virus),...

Ester's utterance was not easy to decode, but as it has been mentioned above, the “high level animal” expression and the corresponding yet untold counter expression “low level animal” that she formed were the most interesting parts of her speech.

Clarissa approached the scientific pattern of the textbook with the only difference of using the verb to have instead of the verb to be in the thematic pattern:

Clarissa: bacteria they have prokaryotic organisms and they are different from human body cells so that's how they live,... But the viruses they live of our own cells like they exploit the metabolism of the human body cell, like you cannot use antibiotics on viruses because then you would damage your own body cells.

Although she used the verb “to have” instead of the verb “to be” in her statement, she aptly denoted the term. In terms of *virus*, Clarissa expressed that *virus* is a non-living organism using the thematic pattern that the “viruses live of our own cells”, explained in different words: “they exploit the metabolism of the human body cell”.

Lindsay wanted to highlight the size of *bacteria* in her utterance.

Lindsay: bacteria, those are living organisms,” she also added: “they are really really small, tiny (smiling),...

Afterwards she reasoned about *virus* as a parasite:

It's a non-living organism, kind of, which will live as a parasite basically in living organism and cause that organism harm. Now I can only think of HIV and stuff, cause that's a kind of virus.

Comparing *virus* to a parasite was very original statement by Lindsay, as it was not mentioned this way by the teacher during the lessons.

When reasoning about *bacteria*, Sabrina simply stated:

Sabrina: bacteria, I've had it myself,....

Considering *virus*, Sabrina gave specific examples of viral infections:

The *virus* is something that can be inside you without being visually seen, I can have herpes for example, without knowing about it, and then I get a cold and then I get a ... , what do you call it, herpes..., on..., your mouth (laughing) and that's the virus showing it.

Zahir reasoned about *bacteria* in the following way:

Zahir: Bacteria, they are living organisms that, ehm, unicellular organisms,...

Then he denoted *virus* as:

Zahir: Viruses are non-living organisms that, you could say, invade your body and cause sicknesses and diseases.

*Bacteria* and *virus* were reasoned by the students in a bigger or a smaller degree with common sense denoting that the language used by the students contained rather everyday features. Lindsay's original expression of comparing *virus* to a parasite is worth mentioning.

### **Concept of fungi**

Although the explanation of the term *fungi* was not mentioned in the unit, the teacher revised the term during the second lesson, when the lecture was given through the powerpoint presentation:

Teacher: fungi is a eukaryote, which means it has a real nucleus, the cell structure is more complicated and it reproduces by spores.

During this presentation, several slides showed common infectious diseases caused by *fungi*.

Jose reasoned about the concept of *fungi* as follows:

Jose: ...fungi, I think about mushrooms (laughing). And about like small particles that come to your skin, that give you diseases and informations.

Similarly as in the previous chapter Jose's for thematic patterns used metaphorical verb expressions such as “small particles that come to your skin, that give you diseases...”

Ester reasoned about *fungi* as decomposers:

Ester: I don't know, fungi is, I don't know, mushroom and it work, I don't know the word, like take away dead body, they use dead body to create enzymes to create, I don't know. Fungi is a different type of a cell from a virus.

By stating that *fungi* “take away dead body” or “use dead body to create enzymes,...” Ester intended to explain that the types of *fungi* that are decomposers break down dead or decaying organisms.

Clarissa attributed *fungi* to mushrooms and decomposers:

Clarissa: ...fungis, well, I kind of know what it is but I don't know how it works or how it reproduces or anything. I think of mushrooms (laughing), cause they belong to the Fungi Kingdom. It's like a group or collective name for same organisms. Then I think of decomposers (smiling).

Lindsay used the verbal construction “cause harm” by stating:

Lindsay: Mostly the fungi part, that it can cause harm to your skin,....

Sabrina's way of reasoning about the term was different in a way that it was connected to an experience of hers:

Sabrina: when we were studying kingdom families, I was studying with my mum who was trying to help me, we were sitting together and she was making funny faces and explaining to me, and she was saying this is like this and you remember, and then when we were writing a test I was just laughing because I remembered what my mum did, that was long time ago.

Sabrina did not reason about the concept itself; she told a little story instead in everyday language.

Zahir presented *fungi* as follows:

Zahir: ...fungi are the types of, you could say, living organisms that grow in the shades of the trees and they, you could say, consume some nutrients from the trees and the grass or the surrounding environment.

It can be figured out from the statement that Zahir was describing mushrooms.

The thematic patterns used by the students were very different from the scientific patterns used by the teacher. An expression “I think of mushrooms” appeared several times. Other interesting metaphorical formulations appeared, such as: “like small particles that come to

your skin, that give you diseases and informations.”(Jose), “Mostly the fungi part, that it can cause harm to your skin,...” (Lindsay). The following example denotes the concept of *fungi* as *decomposers*: “like take away dead body, they use dead body to create enzymes,...”(Ester), “Then I think of decomposers”(Clarissa). However, none of the students mentioned *fungi*'s reproduction or any specific infection they cause.

Before we approach the Language Aspects of the CLIL Environment section, there is another language phenomena that should be reflected in the Language Analysis. Although its investigation was not the primal aim of the analysis, it is worth mentioning, as its essence creates a very important part of the CLIL teaching.

When the terms *bacteria*, *virus*, *fungi* and *pathogen* were being introduced by the teacher and reasoned about by the students, the usage of the singular and plural forms of these terms was not unified. Some of the singular and plural forms were used inaccurately. Specifically, the plural form of the terms *bacteria* and *fungi* was used as a singular (*bacteria* is, *fungi* is...). However, the singular form of *bacteria* is *bacterium* and the singular form of *fungi* is *fungus*. As the plural form was considered by the teacher and consequently by the students as a singular form, the plural form of *bacterium* and *fungus* was mistakenly created from the already plural form *bacteria* and *fungi* by adding the letter -s in the end of the words. Thus, the plural version became *bacterias* and *fungis*.

Here is an example of the mistaken “singular form”, stated by the teacher: “bacteria is a living organism, it is a prokaryote, which means it doesn't have a clear nucleus,...”, “Bacteria has its own body,...”, “ because bacteria shows specific life functions unlike *virus*...” The “plural version” stated by the teacher was: “Salmonella, those are very very dangerous bacterias, also diarrhoea and cholera, these are the basic ones.”

When the students' utterances were analysed, Jose used the term *bacteria* as a singular: “bacteria is a kind of a pathogen that gives you a disease.”

Sabrina used the term *bacteria* similarly in the singular form: “bacteria, I've had it myself,...”

Ester considered the plural form of *fungi* to be singular by stating: “I don't know, fungi is, ..... Fungi is a different type of a cell from a virus.”

Clarissa confused the plural form of *fungi* with the singular and used the incorrect plural form when reasoning about the term pathogen: “viruses, bacteria and fungis are all pathogens and it's something that harms the body, it's like organisms.” Another example would be from reasoning about the term *fungi*: “fungis, well, I kind of know what it is ....”

Lindsay similarly determined the term *fungi* as a singular form by stating: “Mostly the fungi part, that it can cause harm to your skin,...”

When Zahir reasoned about the term *pathogen*, he used the incorrect plural form *fungis*: “pathogens are.. yeah basically viruses, bacterias and *fungis* are types of pathogens.” However, when he was reasoning about the term *fungi*, he used its plural form correctly. “*fungi* are the types of, you could say, living organisms that grow in the shades of the trees and they,...”

### 3. Language Aspects of the CLIL Environment

This section will approach CLIL environment from the students' perspective. In order to find out about CLIL and its influence on the students' learning, the following questions were formed:

- As a non-native English speaker student, can you easily follow the biology lessons taught through English?
- Do you use your mother tongue when studying at home and making your notes? If you do so, in what way?
- Do you find that studying from the textbooks helps you to organize better and extend the achieved knowledge from the lessons?

As it has been already mentioned, the target language of the International Program is English. Although the English language is not a native language to most of the students, they need to appropriate the language as if they were English-native speakers. The students admitted during the interviews that they need to work especially on improving the written academic language, the language of essays and reports, which takes longer to appropriate. What helps them a great deal in the language self-correction is using special softwares for correcting the language when writing essays or reports. The academic language eventually develops on its own by self-learning. Gibbons points out that academic language is very demanding to acquire for a native speaker, and therefore it will be even more demanding for a non-native speaker (Gibbons, 2009). The interviewed students stated that on average, it took them about three months to be able to understand a subject matter of a lesson without any difficulties. The interviewed students also stated that the language improvement comes naturally as they are immersed in the language during most of the lessons.

Regarding the first question, all the interviewed students declared that they had no difficulties following the lessons, except for Ester. Ester's situation was different from the other interviewed students. She joined the biology classes two weeks before this research started to be executed. During the interview she admitted she was having difficulties with following the lessons in English as she felt her knowledge of English was not proficient enough. In order to follow the biology course, she was regularly borrowing notes from a classmate of hers, Jose, and was using his notes as studying material. Her statements recorded for this thesis were mostly based on the knowledge from the previous years when Ester studied in her homeland.

The second question concerned the textbooks that the students study from. Although the students are provided with a large studying material, they find it difficult to combine effectively the notes they take during the lessons and the texts in the books. The lectures seem to be differently structured compared to the books. The students as well as the teacher stated

that the English books proposed for this program seem to be very extensive and complicated. The problematic point is that the text interpretations of the unit in each book focus on different aspects of an investigated unit.

The provided books are meant to be used by English-native speakers, as the aim of this program is to reach the English language proficiency of an English-native speaker. The teacher is aware of how difficult the books are, and therefore she wants to simplify the lectures, to make sure that everyone understands the basic facts. Her strategy is to “give a certain background on which the students can build up their knowledge and with that background they will understand to whatever is in the book”. “When I explain this I put it as simply as possible. You can see that my slides are much more easier than the book.” (extracted from the interview).

Despite the simplicity of the lectures, the students stated they have got problems with distinguishing the essential points in the books on their own as these have not been mentioned during the lessons. It seems that the lectures are explained in a “too much simple” way. “It would be much easier if she (Sophia) gave us exact notes, not just short bullet point notes. The problem is that these bullet points are not always structured, if they were structured, no problem. You can use them as a reference. Imagine to summarize a page like this (pointing at a page in one of the student books, densely covered in writing) with just a few bullet points. It's very hard to do that, even if you did that it would still be very insufficient. I would prefer if she explained what we should know and what we should remember for the exam. Books are quite difficult to understand and it is hard to distinguish what is good or bad info on google.” (interview Zahir). As Zahir indicated in his utterance, the students would prefer to receive more detailed information about the core terms of the subjects, so that they do not feel confused about what is meant to be essential for them to know and what is not.

As Dalton-Puffer points out, “Simplification of content will inevitably have an impact on the simplification of language” (Dalton-Puffer, 2011). Not only content but also language should be studied at the academical level at a high school. This is what may be happening in the case of biology lessons. Not only the content, but the language is being simplified to the degree that the students find difficult to study from the textbooks.

Another aspect being mentioned in this thesis was investigated: In what way the students' mother tongue is effected when most of the instruction at school is taught through English? The purpose of that question was to find out to what extent the students become fully immersed in the target language when they study at home, outside the CLIL environment.

All the interviewed students stated that they use the textbooks in order to make their own notes. They find it hard to take notes during the lessons as the teacher speaks fast. All of the students admitted that they more or less combine their mother tongue with English by interpreting the text into English afterwards. Every student expressed a similar procedure when studying at home and making notes. The procedure was the following: the students form a thought in their mother tongue and consequently the thought is transformed into English by being written down. For example, Jose mixes his mother tongue Spanish with English as there are some pieces of information he finds easier to remember in Spanish: “The processes in biology and chemistry are mostly similar to Spanish, cause most of them are of latin origin.” (extracted from the interview). Ester “thinks” in Chinese first and interprets everything into English before writing it down. Both Clarissa and Lindsay



admitted that Swedish, which is their mother tongue, comes more naturally but they try to think and write everything down in English. Zahir also admitted mixing his mother tongue Arabic with English, but similarly to Clarissa and Lindsay he tries to write everything down in English. Sabrina combines Swedish with English: “In my mind I think in Swedish but I try to write everything down in English, only in case I don't know a word in English, I use the Swedish word that I translate afterwards.” (extracted from the interview). It could be concluded that although the students are fully immersed into studying in English, it is still their first language from which their thinking and consequently meaning making unfolds.

In the Analytic Procedure the overall scheme of the conducted research was proposed, followed by the section of Findings which was divided into two subchapters of Content Analysis and Language Analysis. The Content Analysis investigated the formation of the chosen concepts from the content point of view, exploring its development from the textbooks, through the teacher's representation to the students' reasoning about the concepts. A similar procedure was conducted in the Language Analysis that focussed on the thematic patterns used in school science language combined with everyday language that characterize the concepts.

## 8. Discussion

In this section, the results from the Analytic Procedure will be summarised and reflected upon. “Defence Against Infectious Diseases” was the name of the unit of the biology lessons that was studied for this thesis. One of the most important objectives of the unit was to conceive how to prevent a human organism from being infected by a harmful pathogen. Hence, the outcome of this unit was to learn three major pathogens causing diseases, namely *bacteria*, *virus* and *fungi*, to appropriate the meaning of the terms situated in the context of pathogens. Thus, the terms *pathogen*, *virus*, *bacteria* and *fungi* were chosen to be analyzed as they represent the core knowledge of the unit. The formation, representation and reasoning about these terms were the main subjects of the analysis.

The analysis was divided into three parts: Content Analysis, Language Analysis and the third part reflected upon the CLIL environment in the classes of biology at the high school education level.

Content Analysis investigated to what extent meaning of scientific patterns of the concepts would change or evolve when reasoned about by the students. Language Analysis had a similar intention by investigating chosen parts of speech joined within the thematic patterns that characterize the concepts. The CLIL analysis focused on three questions given to the students during the interviews. The questions concerned about how the students find studying in English being non-native speakers.

### 1. Content Analysis

The objective of the Content Analysis was to investigate meaning and its potential change in the students' concept formation derived from the way the concepts were represented in the textbooks and by the teacher's representation.

One of the aims of investigating the term *pathogen* was to find out whether the students would determine *pathogen* as an overall term for *virus*, *bacteria* and *fungi*. All the students associated *pathogen* with the fact that *pathogen* can cause diseases. However, it was not always clear from the statements whether the students realised the relationship between *pathogen*, *bacteria*, *virus* and *fungi*. Only two out of six students (Clarissa and Zahir) clearly stated that *bacteria*, *virus* and *fungi* can be types of *pathogens*. Ester did not include the term *fungi* into the statement about *pathogen*. Only half of the interviewed students appropriated the concept and the rest of the students had a vague memory or could not recollect the concept at all (Sabrina), which is slightly disturbing as *pathogen* was one of the main key terms of the unit.

Concerning *bacteria* and *virus*, about half of the students represented the meaning of bacteria and virus as scientific concepts, unlike the second half of the students introduced the concepts as spontaneous by putting a higher amount of common sense in the meaning (Lemke, 1990). The teacher gave a very detailed information about how do *bacteria* and *viruses* reproduce and what is the difference between them. What most of the students remembered was the fact that a viral infection cannot be treated by antibiotics. However, none of the students mentioned neither the reproduction of *bacteria* or *virus*, nor the examples of bacterial and viral infections (apart from Lindsay and Sabrina).

When it comes to the concept of *fungi*, five out of six interviewed students (Jose, Ester, Clarissa, Sabrina and Zahir) reasoned about the concept by using their common sense by stating they associate it to mushrooms. As the meaning of the concept of *fungi* did not approach the scientific meaning of the textbooks, it can be concluded that the concept of *fungi* was reasoned about by the students as a spontaneous concept. It shows that for some reason the concept of *fungi* as *pathogen* was not properly formed.

The students had difficulties to reason about the term, as if they had no recollection of what they were taught during the lesson. None of the students talked about reproduction of *fungi* and none of them mentioned any specific example of an infection caused by *fungi*, although the teacher did. When it comes to the textbooks, the term *fungi* was not explained in the studying materials. It was only mentioned in connection to the explanation of *pathogen* in the textbooks where it was stated that “The range of disease-causing organisms that may infect humans includes not only microorganisms such as certain bacteria and fungi, but also viruses, ....” (Textbook 2). The fact that the students reasoned about the concept as spontaneous and did not have any recollection of the concept as scientific can explain why the students seemed not to have retained the information they received during the lessons and transformed it into the knowledge. In other words, as the concept of *fungi* was not mentioned in the textbooks the students did not have any recollection of the concept.

Another reason may lie in the way of introducing and discussing the unit by the teacher (Gibbons, 2009). For introducing and discussing a unit, the teacher uses either “chalk and talk” or a powerpoint presentation. “Chalk and talk” is simply a lecture given by the teacher while writing the essential facts on the whiteboard. When giving a powerpoint presentation, the teacher provides the students by the slides from the presentation. In case of the investigated unit “Defence Against Infectious Diseases”, the first lesson was given by means of “chalk and talk” and the second lesson by a powerpoint presentation. Most of the

interviewed students mentioned that although the powerpoint presentations are interesting, as the students get to see many pictures, they cannot write down any notes as the teacher speaks fast and does not write the facts on the whiteboard. Concerning the investigated lessons, *pathogen*, *bacteria* and *virus* were introduced during the first lesson of the unit “chalk and talk” and repeated with more examples during the powerpoint presentation. The concept of *fungi* was not mentioned during the first “chalk and talk” lesson. It was not mentioned until the powerpoint presentation. As a result of these facts, presenting the concept of *fungi* during the powerpoint presentation did not seem to be enough to form and retain the concept by the students.

There can be another explanation going back to the times when the students formed the concept of mushroom as a spontaneous concept even before attending school (Vygotsky, 1986). Later on, when they first learned about the Kingdom of Fungi at school, mushrooms again maintained the largest representation of the Kingdom of Fungi. In the languages of the latin origin such as Italian, Spanish, French and Portuguese, the dictionary meaning of the term *fungus* stands for mushrooms. Therefore, the concept of *fungi* as mushrooms had to be deeply embedded in the students' minds before encountering the concept of *fungi* as *pathogens*, therefore automatically attributed to mushrooms. All these reasons could explain why the concept of *fungi* represented as *pathogens* was not retained properly in the students' memory.

The notion of the concept formation introduced by Vygotsky and Lemke in the Theoretical Background, which was put into practice in the Analysis, proved that content and form are inextricably connected. In order to “talk science”, the content formed by scientific language must approach semantically the original scientific pattern written in a textbook (Lemke, 1990). The scientific concept will be transformed into spontaneous by implementation of everyday language in the thematic pattern. This statement also leads to a presumption that meaning of a concept can be expressed on several levels depending on the language use. Either school science or everyday language will determine the level on which meaning will be expressed. In other words, whether the concept will become scientific or spontaneous.

## 2. Language Analysis

The aim of the Language Analysis was to investigate how school science language and everyday language would develop within the thematic patterns formed by the students during the process of concept formation. The analysis was proceeded in the following steps: firstly, an explanation extracted from textbooks was introduced; secondly, the teacher's way of representing a concept from the recorded lesson was given; and thirdly, the students' quotations from the interviews were presented. The concept formation observed from the language perspective studied semantic relationships of parts of the speech such as nouns, adjectives and verbs, used in the thematic patterns that characterize the concepts. The scientific patterns from the textbooks and the teacher's scientific patterns were semantically compared to the thematic patterns formed by the students during the interviews.

Every student's utterance varied. The meaning of *pathogen* stating that it can cause or causes diseases was shifted into a more straightforward role stating that *pathogen* “affects”, “harms” or even “attacks” human body. By using these action verbs the students formed metaphorical expressions that narrowed down and specified the “intention” of *pathogen*. On the students' representation *pathogen* cannot only cause diseases, but it affects!, harms! and

attacks! the human body. The usage of these action verbs can originate in the fact that already the title of the unit is called “Defence Against Infectious Diseases”, which evokes the feeling of defending something against an attack.

Similarly as in the case of *pathogen*, about half of the students represented the meaning of *bacteria* and *virus* as scientific concepts, unlike the second half of the students introduced the concepts as spontaneous by putting a higher amount of common sense in the meaning (Lemke, 1990). Therefore there were thematic patterns that semantically did not approach the scientific pattern of the textbook as the common sense and everyday language prevailed in those thematic patterns. An example would be Lindsay mentioning that “bacteria are tiny” or Sabrina stating “I’ve had it myself”(also meaning bacteria).

The thematic patterns characterizing *fungi* semantically differed from the teacher’s scientific pattern. Everyday language was the prevailing language of the thematic patterns. As there was no thematic pattern about the concept of *fungi* found in the textbooks, it was only the teacher’s scientific pattern that was used as an initial model. Most of the students associated the concept of *fungi* to mushrooms at the first place. The term was also reasoned about as decomposers by Ester and Clarissa. Jose and Lindsay mentioned *fungi* in connection to the concept of *pathogen*. Nobody, apart from Ester, denoted *fungi* as a eukaryote (unlike *bacteria* which most of the students denoted as prokaryote). However, the reader has to figure out the information from Ester’s statement: “fungi is a different type of a cell from a virus”. None of the students mention reproduction of *fungi*. There were no specific examples of fungal infections. It seems that the students do not retain the information from the lessons. The interviewed students admitted that as the teacher’s pace of giving lectures is fast, they do not have time to take notes, they can only listen and take notes from the textbooks afterwards. If the textbooks are too complicated the students cannot find the information they need and do not meet the teacher’s requirements, which may cause problems.

From the language point of view, the teacher’s sentence structures seem to be simpler. It could be stated that the teacher aims to preserve scientific language by using scientific terms, yet in the simple sentence structures. However, supposedly she speaks so fast that the students can “sort of” (interview Lindsay) understand, but it is impossible to write down notes at the same time. Therefore the students need to closely work with the textbooks that are unfortunately too dense and complicated for them. The question remains: Is it a good strategy to combine very complicated books with lectures given in a simple language, yet in a very fast pace?

According to the students it seems not. They are struggling with recognizing with what is important to remember and what is less important. The solution would be to reconsider changing studying materials by the management; or even better if the teacher could prepare notes that can be used by the students for future studying so that they do not have to make their own notes at home and so that they can easily understand the subject matter of the unit. In the language analysis it is pointed out that as the teacher simplifies the content, the language will be inevitably simplified too. It is true that the sentence structures used by the teacher are simpler. On the other hand, as some of the transcribed texts show, she gives even more detailed information than the textbooks. It is a shame that the students do not retain that.

### 3. CLIL Analysis

Most of the interviewed students stated that it took them about three months to feel immersed enough into teaching through English language in order to follow the lessons. All the interviewed students admitted that despite the education provided in English, their mother tongue is still the initial source of expressing themselves; and most of the time they interpret the thoughts from their mother tongue into English.

The part of the Language Analysis discussing Language Aspects of the CLIL environment was investigating a question about which language is the leading one for the students when studying from the textbooks and taking notes. All the interviewed students admit they think in their mother tongue first. Then, they interpret the thought into English in order to write down notes in English. Is this procedure of interpreting permanent? When it comes to the concept formation, which language will the concept be formed in? Does it mean it will be formed in the students' mother tongue and consequently interpreted into the target language? The answers to these questions may not be fully clarified in this thesis, but it seems that firstly, a concept in the students' mother tongue is formed. Secondly, to be able to reason about the concept in English, another concept in English unfolding from the “mother tongue concept” is formed. Consequently, the concept formed in English becomes the one preferably used by the students as the language of instruction in their school setting is English.

As Alex Kozulin mentions in Vygotsky's Thought and Language, when we find ourselves in a different language environment, “especially at the beginning we will most likely use our mother tongue when using our inner voice, in our inner speech, or we will practise or play with newly acquired language forms by combining them with our mother tongue” (Vygotsky, 1986, xvii). However, the mother tongue inner voice may gradually fade as the usage of the language of instruction will prevail.

### 4. Generalisation and Validity

The concept of generalisation, in Vygotsky's meaning, was achieved only partially as the interviews still took place in the school setting. Although the interviewer intended to make the students feel at ease, they might have felt under pressure of being “informally” examined. Both Vygotsky and Lemke stated that meaning of a concept can vary, depending on the context it is situated in. It could be not only the context of the speech, but also the context of environment as it is pointed out when describing the methodology of the interviews. The process of generalisation is related to both the environment and the context the concepts are formed in.

Moreover, in case that in the context of speech the process of generalisation is not fully realised, the students create several concepts of meaning instead that they cannot interconnect although the meanings are related to one concept. This may explain why later on, when the concept of *fungi* was introduced in the context of pathogens, the students had difficulties to unite the already known concept of *fungi* as mushrooms with the concept of *fungi* as pathogens or decomposers. It could be concluded that learning is not only based on the creation of new concepts, but even more importantly it is based on the continuous formation of the concepts already created, depending on the context in which the concepts are situated (Vygotsky, 1986).

This form of total CLIL teaching where all the content subjects are taught through the target language occurs mostly in the International Programs. Therefore a question could be raised: To what extent is this study relevant for the other school programs using this form of total CLIL teaching? This is the question of methodological generalisation. The target language, English, is used the same way as if it was the students' mother tongue. The IB program follows the same curricula in every part of the world. It means this case is generalisable to any IB program in any part of the world. Outside the International Schools, it depends to what extent the target language is involved in teaching. In Sweden for example, there are no set rules for the CLIL implementation on the National level (Sylvén, 2013), which means that the amount of the target language instruction can vary from school to school as each school decides to what extent the CLIL teaching will be implemented. The way this case study is generalisable and valid in relation to the IB programme derives from the amount of the target language implementation.

This case study shows that the students enrolled in the IB Program are expected to master their language at the level approaching their mother tongue. However, they often struggle with grasping meaning of the concepts. The similar or even bigger kinds of problems are very likely to be expected at other schools where immersion teaching is implemented as well.

However, there can be another side of the coin: if the immersion teaching is realised to a smaller degree, therefore combined with the students mother tongue during the lessons, it may increase the level of understanding.

## **9. Summary**

In this thesis, a case study research of a classroom of 32 students in grade 11 was depicted. The research was conducted in a school with an international profile. Two video-recorded lessons presenting the unit “Defence Against Infectious Diseases” became the main data for this study, together with the recorded interviews with six students and the classroom teacher.

The aim of the thesis was to investigate how the high school students form the concepts in the classes of biology. The research found out that the students easily combine school science language and everyday language. Everyday language enables them to express themselves in case they “run out of” vocabulary in school scientific language or in case they give specific examples from everyday life experience.

## **10. Conclusion**

This case study investigated the concept formation presented by the students that were extracted from the unit “Defence Against Infectious Diseases”. The development of the concept formation from the textbooks through the teacher to the students and the formation itself created the essential structure of this research.

The analysis derived from the theory of Vygotsky about scientific and spontaneous concept formation through scientific and everyday language; and from Lemke's theory who shared a similar opinion with Vygotsky stating that science needs to be talked through in order to be appropriated (Lemke, 1990). The concepts were analyzed through scientific and thematic patterns. Scientific patterns were extracted from the textbooks and from the teacher's statements from the lessons; unlike thematic patterns which were formed by the students during the interviews. Within the thematic patterns, mainly the usage and choice of parts of speech were analyzed. Various usage of mainly nouns, adjectives and verbs joined in patterns proved that meaning can be formed

on different kind of levels; from scientific level formed by school science language, to spontaneous level where common sense prevails in a form of everyday language (Lemke, 1990).

During the concept formation some of the concepts, mainly *bacteria*, *virus* and *pathogen* were formed by about half of the students into scientific concepts and by an other half into spontaneous concepts. Drawing upon the results from this study the research has revealed that pre-understanding of the concepts on their spontaneous level affects their following formation of the same concepts but on the scientific level (Vygotsky, 1986).

This result indicates that it is the teacher's scaffolding, when introducing the concepts, that plays the most important role in forming and consolidating the concepts (Gibbons, 2009). The special attention should be devoted at pointing out both scientific and spontaneous meanings of each concept in order to make the students realize that one concept can have several meanings (Vygotsky, 1986).

## **1. Further Research**

The following study of this research could analyze more the Content and the Language Analysis in order to deepen and elaborate the study a bit more. In the further studies of this thesis I would illuminate concept formation through thematic patterns by analyzing rhetorical language, more specifically, explicit metaphors used by the students when talking science.

What would also need to be studied more in detail is executing this research from the teacher's point of view, to focus more on the teacher's needs in order to find out how can the education be improved. The same thought is related to the textbooks. It would be interesting to investigate how a better choice of textbooks can improve the students learning and understanding.

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